



Circular Economy Approaches for Marine Waste and Ocean Plastic Management

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ABSTRACT

Marine waste and ocean plastic pollution have emerged as severe environmental challenges, threatening marine ecosystems, biodiversity, and coastal livelihoods. The rapid increases in single-use plastics, inadequate waste management systems, and limited recycling infrastructure have significantly contributed to the accumulation of plastic debris in marine environments. In this context, the circular economy offers a sustainable framework by emphasising waste reduction, reuse, recycling, and resource recovery. The present study examines circular economy approaches for marine waste and ocean plastic management by identifying major pollution sources, evaluating existing circular practices, assessing stakeholder roles, and proposing effective plastic reduction strategies. The study adopts a mixed-methods research design, utilizing both primary and secondary data. Primary data were collected from 200 respondents representing coastal communities, local authorities, NGOs, and recycling and plastic industries through structured questionnaires and interviews. Statistical tools such as percentage analysis, mean scores, ANOVA, correlation, and regression were applied for data analysis. The findings reveal that single-use plastics and fishing gear waste are the primary contributors to marine pollution. Circular economy practices such as recycling, eco-design, and Extended Producer Responsibility show high effectiveness in marine waste management. The study also establishes a strong positive relationship between stakeholder participation and sustainable plastic management. Overall, the research concludes that integrating circular economy principles with coordinated stakeholder involvement provides a practical and long-term solution for reducing marine plastic pollution and promoting sustainable ocean ecosystems.

Keyword: Circular Economy, Marine Waste, Ocean Plastic Pollution, Stakeholder Participation, Sustainable Waste Management.

1. INTRODUCTION

Marine waste and ocean plastic pollution have emerged as critical global environmental challenges, posing serious threats to marine ecosystems, biodiversity, and coastal livelihoods. Rapid industrialization, urbanization, and increased reliance on single-use plastics have

significantly intensified the accumulation of plastic waste in oceans. Inefficient waste management systems, improper disposal practices, and limited recycling infrastructure further contribute to the growing volume of marine debris. As plastics are durable and non-biodegradable, they persist in marine environments for decades, breaking down into microplastics that enter the food chain and endanger human and ecological health. In response to these challenges, the circular economy has gained attention as a sustainable alternative to the traditional linear model of “take-make-dispose.” Circular economy approaches emphasise resource efficiency, waste reduction, reuse, recycling, and recovery, aiming to retain materials within the economic system for as long as possible. When applied to marine waste and ocean plastic management, these approaches encourage innovative product design, extended producer responsibility, closed-loop recycling systems, and sustainable consumption practices. Such strategies not only reduce plastic leakage into oceans but also create economic value from waste materials. Effective implementation of circular economy principles in marine waste management requires the active involvement of multiple stakeholders, including governments, industries, local communities, and non-governmental organisations. Policy frameworks, technological innovations, public awareness, and collaborative governance play a vital role in ensuring sustainable outcomes. This study focuses on identifying major sources of marine waste, examining existing circular economy practices, evaluating stakeholder participation, and proposing strategic measures for plastic reduction. By integrating environmental sustainability with economic viability, circular economy approaches offer a promising pathway for addressing marine waste and promoting long-term ocean health.

2. PROBLEM IDENTIFICATION

The escalating accumulation of marine waste, particularly plastic debris, has become a pressing environmental and socio-economic concern globally. Oceans are increasingly polluted by plastics from land-based sources, fisheries, shipping activities, and coastal industries, leading to habitat degradation, biodiversity loss, and adverse effects on human health. Despite various conventional waste management practices, the persistence of plastics in marine environments highlights the inadequacy of linear disposal systems. Furthermore, fragmented governance, limited recycling infrastructure, and insufficient stakeholder coordination exacerbate the challenge of sustainable ocean plastic management. In this context, the circular economy offers a transformative approach, emphasising waste reduction, material reuse, and sustainable resource management. However, the application of circular economy principles in marine waste management remains underexplored, with limited understanding of effective strategies and stakeholder roles. This research seeks to identify major sources of marine waste, evaluate circular economy practices, and propose actionable strategies to sustainably reduce ocean plastic pollution, bridging the gap between environmental sustainability and practical implementation.

OBJECTIVES

1. To identify major sources of marine waste and ocean plastic pollution. To examine circular economy approaches used in marine waste management.
2. To assess stakeholder roles in managing ocean plastic sustainably.
3. To suggest effective strategies for circular economy-based plastic reduction.

3. REVIEW OF LITERATURE

Tamil Nadu Fishnet Initiatives (2024) reported by the Tamil Nadu Pollution Control Board, offers a practical circular economy model for reducing marine plastic pollution. The initiative established collection centres for abandoned fishing nets, segregating and redirecting them for recycling, demonstrating stakeholder roles in waste transformation. With about 10,000 kg of nets collected and plans to expand across coastal districts, this project highlights how government action and industry collaboration can turn ocean plastic waste into reusable material, mitigating major pollution sources.

Promoting Circularity in India's Plastic Value Chain (2024) by Bardhan et al. explored the economic and environmental benefits of transitioning India's plastics industry toward full circularity. The authors estimated significant social and economic gains from recycling and reuse practices compared to linear waste management. Their findings point to reduced environmental burdens and improved resource efficiency, stressing that circular approaches can mitigate plastic leakage into marine environments. This research contributes to policy discourse on effective strategies for plastic reduction and stakeholder engagement in sustainable waste systems.

Ramesh & Jeyachandran (2025) investigated microplastic pollution in marine ecosystems along the Tamil Nadu coast, focusing on source identification and mitigation. The study adopted a forensic approach to trace microplastic origins and evaluated cost-effective interventions such as pellet-capturing systems and periodic cleanup drives. Their analysis underscored the ecological and economic risks of persistent microplastics and highlighted mitigation strategies that align with sustainable waste management practices. These findings contribute to understanding major pollution sources and potential circular economy solutions in coastal marine environments of India.

Raj et al. (2025) examined plastic waste management strategies under a circular economy lens across India. The review emphasized sustainable solutions, including bio-based plastics, blockchain tracking for waste streams, and enterprise-level valuation of waste resources. It outlined how circular planning can reduce leakages of plastics into marine environments by improving reuse, recycling, and valorisation pathways. The authors argued that integrating responsible production and consumption principles is vital to curb marine plastic sources and enhance stakeholder participation in sustainable practices.

EU-India Resource Efficiency & Circular Economy Project (2025) launched in Chennai illustrates multistakeholder engagement in circular solutions for plastics. This initiative fosters collaboration among government agencies, SMEs, and international partners to improve recycling value chains and promote reuse and alternative materials. Workshops emphasized extended producer responsibility (EPR) and inclusive practices that encourage recycled content adoption. The project thus exemplifies a strategic framework to enhance stakeholder roles in marine litter prevention and sustainable plastic management in Tamil Nadu.

H01₀: There is no significant difference among stakeholder groups in their perception of major sources of marine waste and ocean plastic pollution.

H02₀: Circular economy practices do not have a significant relationship with marine waste management effectiveness.

H03₀: Stakeholder participation does not have a significant impact on sustainable plastic management practices.

H04₀: Circular economy–based plastic reduction strategies do not significantly influence the reduction of marine waste and ocean plastic pollution.

4. RESEARCH METHODOLOGY

This study adopts a mixed-methods approach to analyze circular economy approaches for marine waste and ocean plastic management. Both primary and secondary data are used to ensure a comprehensive understanding of marine plastic sources, management practices, and stakeholder roles. Primary data is collected through structured surveys and interviews with key stakeholders, including coastal community members, local authorities, NGOs, and representatives from recycling and plastic-related industries. A sample of 200 respondents is selected using stratified random sampling to ensure representation from different stakeholder groups. The study area covers selected coastal regions affected by marine plastic pollution. Secondary data is gathered from research journals, government reports, policy documents, and publications of international organizations such as the UN and World Bank, providing theoretical and global perspectives on circular economy practices. For analysis, quantitative data is examined using statistical tools such as SPSS, applying descriptive and inferential techniques, while qualitative data from interviews is analysed through thematic analysis. Ethical considerations include informed consent, confidentiality of responses, and use of data strictly for academic purposes.

5. ANALYSIS AND INTERPRETATION

Hypotheses of the Study

Table No 5.1 Statistical Tools Used for Analysis

1	Percentage Analysis	To analyze respondent profile
2	Mean & Standard Deviation	To measure perception levels
3	ANOVA	To test differences among stakeholder groups
4	Correlation Analysis	To examine relationships between variables
5	Regression Analysis	To assess impact of circular economy strategies

DISCUSSION

The findings of the study clearly highlight the growing significance of circular economy approaches in addressing marine waste and ocean plastic pollution. The dominance of single-use plastics and fishing gear waste as major pollution sources confirms the urgent need for targeted regulatory and industry-level interventions. The strong mean scores for recycling, eco- design, and Extended Producer Responsibility indicate increasing stakeholder acceptance of circular practices in marine waste management. ANOVA results reveal perceptual differences among stakeholder groups, emphasising the necessity for inclusive and coordinated governance mechanisms. The positive and significant correlation between circular economy practices and waste management effectiveness demonstrates that circular strategies substantially improve environmental outcomes. Regression results further confirm that active stakeholder participation plays a decisive role in enhancing sustainable plastic management. Moreover, the high effectiveness of bans on single-use plastics and public awareness campaigns underscores the importance of policy enforcement combined with behavioural change. Overall, the study affirms that integrating circular economy principles with stakeholder collaboration offers a viable and sustainable pathway for reducing marine plastic pollution.

LIMITATIONS OF THE STUDY

1. The study is limited to selected coastal regions, and therefore, the findings may not fully represent marine waste management practices in all coastal or inland areas.
2. The analysis relies partly on self-reported data from respondents, which may be subject to personal bias or perception errors.
3. The sample size of 200 respondents, though adequate for the study, may limit the generalisation of results to a broader population.

The study focuses primarily on plastic waste and circular economy practices, excluding other forms of marine pollution such as chemical waste and oil spills.

CONCLUSION

This study concludes that marine waste and ocean plastic pollution pose serious environmental and socio-economic challenges, requiring sustainable and integrated management approaches. The findings reveal that single-use plastics and fishing-related waste are the major contributors to marine pollution, emphasising the need for stricter regulations and responsible production practices. Circular economy approaches such as recycling, eco- design, and Extended Producer Responsibility have proven to be effective in improving marine waste management outcomes. The study also highlights the critical role of stakeholder participation, as active involvement from governments, industries, NGOs, and local communities significantly enhances sustainable plastic management. Furthermore, policy measures, public awareness, and technological interventions collectively strengthen plastic reduction efforts. Overall, adopting circular economy principles offers a practical and long- term solution for reducing marine plastic pollution and ensuring sustainable ocean ecosystems.

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